PROC. BIOL. SOC. WASH.
95(3), 1982, pp. 440–450

A NEW SPECIES OF SKATE FROM THE WESTERN INDIAN OCEAN, WITH COMMENTS ON THE STATUS OF *RAJA* (*OKAMEJEI*) (ELASMOBRANCHII: RAJIFORMES)

John D. McEachran and Janice D. Fechhelm

Abstract.—*Raja* (*Okamejei*) *heemstrai* n. sp. is described from six specimens captured off Kenya and Tanzania. Within *Okamejei* the new species most closely resembles *R. powelli* in possessing a rhomboid-shaped disc, relatively long pointed snout and large interspace between the dorsal fins. The two species can be distinguished from each other by several proportional measurements, number of tooth rows in the upper jaw, coloration, and structure of neurocranium and scapulocoracoids. The third *Okamejei* species from the Indian Ocean, *R. philipi,* appears to be synonymous with *R. powelli* but the holotype and only known specimen of *R. philipi* has been lost and its status remains uncertain. *Raja* (*Okamejei*) is compared with *R.* (*Dipturus*) and it is concluded that only the structure of the anterior margin of the anterior neurocranial fontanelle distinguishes the two subgenera. The second known specimen of *Cruriraja andamanica* is briefly described and compared with the holotype of the species.

Stehmann (1976) revised the poorly known skate fauna of the tropical Indo-West Pacific and concluded that only 10 species occur in this vast area. He stated that the skate genera-subgenera *Breviraja* (3 spp.), *Cruriraja* (1 sp.), *Raja* (*Amblyraja*) (1 sp.), *R.* (*Dipturus*) (1 sp.), *R.* (*Okamejei*) (2 spp.), *R.* (*Rajella*) (1 sp.) and *R.* (*Rostroraja*) (1 sp.) occur in the area and that this area has served as a migration route or passage between the Pacific and Atlantic oceans rather than an area of colonization. Recently McEachran and Fechhelm (1982) described a new species of *Pavoraja* from the eastern Indian Ocean, and herein we describe another species of *R.* (*Okamejei*) from the western Indian Ocean. This suggests that more intensive collecting may reveal that the deeper waters of the tropical Indo-West Pacific support a rather diverse skate fauna. We also discuss the status of the other two Indian Ocean *R.* (*Okamejei*) species, distinctions between *R.* (*Okamejei*) and *R.* (*Dipturus*), and comment on the second known specimen of *Cruriraja andamanica*.

Specimens of the new species were obtained from the Rhodes University, Grahamstown, South Africa (RUSI) and the Zoologisch Museum Universiteit van Amsterdam (ZMA). Specimens of *Raja* (*Okamejei*) *powelli* and *Cruriraja andamanica* were obtained from the British Museum (Natural History) (BMNH) and ZMA respectively. One specimen each of the new species and *R. powelli* was dissected to reveal the structure of the neurocranium and scapulocoracoids. The remaining specimens were radiographed to verify the anatomical observations based on dissections and to count vertebrae, pectoral radials and pelvic radials. Methods for making measurements and counts follow McEachran and Compagno (1979, 1982).

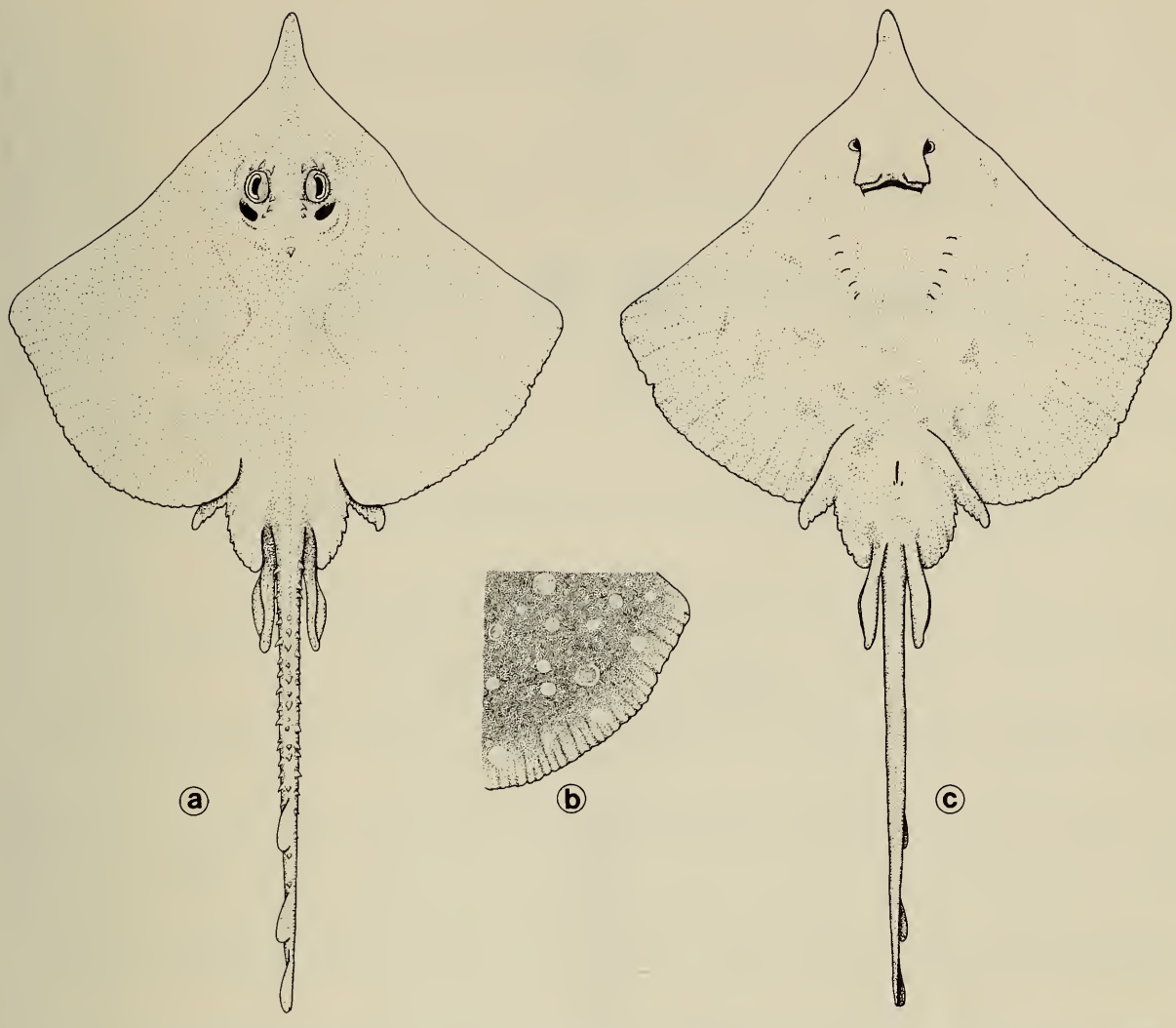

Fig. 1. *Raja heemstrai* RUSI 13812 (Holotype). a. Dorsal view; b. Distolateral section of right pectoral fin showing color pattern; c. Ventral view.

Raja (*Okamejei*) *heemstrai,* new species
(Figs. 1, 2)

Holotype.—RUSI 13812, 404 mm TL, adolescent male, collected off Kenya, 02°59′S, 40°25′E, 260 m, 12 December 1980, aboard R/V "*Fridtjof Nasen*" by Philip C. Heemstra.

Paratypes.—RUSI 15920, 515 mm TL, adolescent female, 458 mm TL, 365 mm TL juvenile females; USNM 231866, 419 mm TL, adolescent male; all collected with holotype. ZMA 113.399, 219 mm TL, juvenile male, collected off Tanzania, near Dar es Salaam, ca. 07°S, 40°E, 274–457 m, 26–28 June 1974.

Diagnosis.—Disc rhomboid-shaped; snout about one-half head length; preorbital length 14.9–17.1% of total length; orbital diameter greater than interorbital distance; spiracle length about one-half orbit diameter; distance between first gill slits 11.6–13.2% of total length; distance between fifth gill slits 6.9–7.9% of total length; teeth in upper jaw 31–35; distance between dorsal fins greater than length of first dorsal fin base; dorsal surface with numerous symmetrically arranged ocelli, consisting of narrow yellow rings surrounding brown or tan centers.

Description.—Disc 1.2 times as broad as long (Table 1); maximum angle in front of spiracles 80° in holotype (71°–90° in paratypes); margin of disc concave

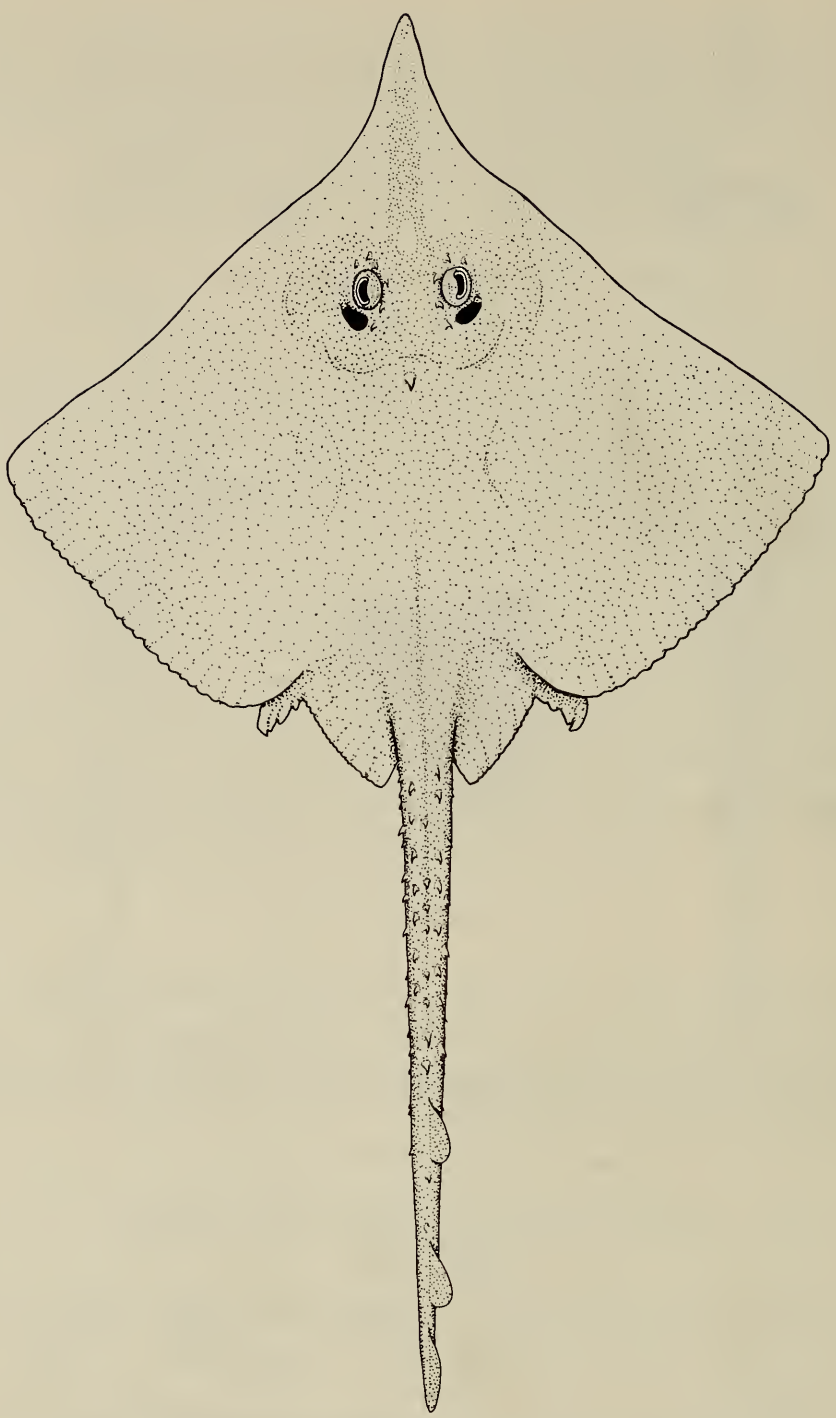

Fig. 2. *Raja heemstrai* RUSI 15920 (Paratype, 515 mm TL, female), dorsal view.

from tip of snout to midlength of snout, slightly convex from midlength of snout to level of orbits, slightly concave from level of orbits to outer corners, outer corners narrowly rounded, posterior margins slightly concave laterally, but slightly convex medially. Axis of greatest width 76% (69–75%) of distance from tip of snout to axil of pectoral fins. Pelvic fins moderately incised, anterior lobe narrow and acutely pointed, anterior margin 78% (71–85%) as long as distance from origin of anterior lobe to posterior extreme of fin. Tail slender, little depressed, its width at midlength about two-thirds diameter of eye. Tail with narrow lateral fold along ventrolateral surface, running from axil of pelvic fin to near tip of tail. Length of tail from center of cloaca to tip 1.2 (1.1–1.3) times distance from tip of snout to center of cloaca.

Table 1. Proportional measurements and meristic values of *Raja heemstrai* n. sp., *R. powelli* and *Cruriraja andamanica*. Proportions are expressed as percentage of total length.

	Raja heemstrai							*Raja powelli*		*Cruriraja andamanica*	
	RUSI 13812	RUSI 15920	RUSI 15920	RUSI 15920	USNM 231866	ZMA 113.399		BMNH 1935.5.24:17–18		ZMA 113.400	
Sex	♂[1]	♀[2]	♀[2]	♀[2]	♂[2]	♂[2]	$\bar{x}$	♂	♀	♂[3]	♀
Total length (mm)	404	515	365	458	419	219		347	347	207	179
Disc width	58	59	56	59	59	63	59	61	63	53.1	56
Disc length	50	49	49	51	48	53	50	53	53	42.5	42
Snout length (preocular)	15.3	16.7	17.1	17.1	14.9	16.1	16.2	15.9	15.3	10.1	10.6
Snout length (preoral)	16.6	17.8	18.6	18.4	15.9	17.3	17.5	17.0	16.9	14.0	12.7
Snout to maximum width	33.2	31.3	32.2	33.8	31.5	32.0	32.4	30.2	32.0	—	27.4
Prenasal length	13.7	14.7	15.5	15.5	13.2	14.2	14.5	13.4	12.9	—	9.5
Orbit diameter	3.6	3.7	3.8	3.8	3.7	4.0	3.7	3.5	3.6	4.8	4.2
Distance between orbits	3.4	3.5	3.5	3.4	3.4	3.7	3.5	4.8	4.5	3.6	3.3
Orbit and spiracle length	4.8	4.9	4.7	4.9	5.0	4.9	4.9	5.4	5.4	5.8	4.9
Spiracle length	1.7	1.8	1.3	1.5	1.3	1.7	1.6	1.9	2.1	2.4	1.7
Distance between spiracles	5.0	5.4	5.1	5.4	5.2	5.6	5.3	5.6	5.6	6.5	6.3
Mouth width	6.7	6.6	6.5	7.0	7.0	7.4	6.8	8.2	8.7	5.8	5.7
Nare to mouth	4.5	4.1	4.2	4.0	4.2	4.7	4.2	4.4	4.5	—	3.7
Distance between nostrils	6.7	6.5	6.9	6.8	6.8	7.2	6.8	7.6	7.6	6.3	5.7
Width of first gill opening	1.3	1.4	1.4	1.5	1.3	1.4	1.4	1.5	1.7	0.7	0.7
Width of third gill opening	1.2	1.5	1.1	1.2	1.2	1.4	1.3	2.0	1.9	1.0	0.8
Width of fifth gill opening	0.8	0.8	0.7	0.7	0.8	1.0	0.8	1.4	1.5	1.2	0.6
Distance between first gill openings	11.9	12.5	12.2	12.8	11.6	13.2	12.3	16.7	16.7	14.5	11.5
Distance between fifth gill openings	7.1	7.9	6.9	7.7	6.8	7.6	7.4	8.5	8.6	7.2	5.6
Length of anterior of pelvic lobe	10.4	9.5	10.0	9.5	10.9	11.6	10.3	10.0	11.6	11.1	14.4
Length of posterior pelvic lobe	13.4	11.9	12.1	13.4	13.2	13.6	12.9	14.0	14.7	—	—
Tail width at axil of pelvic fins	2.7	2.9	2.8	3.0	2.8	3.0	2.9	2.6	3.2	—	—
Distance—snout to cloaca	46	48	46	47	44	48	46	48	48	39.1	38
Distance—cloaca to first dorsal fin origin	33	38	33	31	35	33	33	32	34	49.3	46
Distance—cloaca to caudal fin origin	49	47	48	47	51	47	48	46	48	—	58
Distance—cloaca to caudal fin tip	54	52	54	52	56	52	53	52	52	60.9	62
Number of tooth rows (upper jaw)	31	34	32	33	34	35	33.2	75	72	—	43
Number of trunk vertebrae	29	30	29	30	30	29	29.5	30	31	22	23
Number of predorsal tail vertebrae	50	49	53	48	50	47	49.5	55	49	—	58
Number of pectoral fin radials	80	78	78	79	78	80	78.8	78	77	58	58
Number of pelvic fin radials	20	23	22	22	21	19	21.2	19	19	—	—

1. Holotype 2. Paratypes 3. Holotype data from Stehmann (1976).

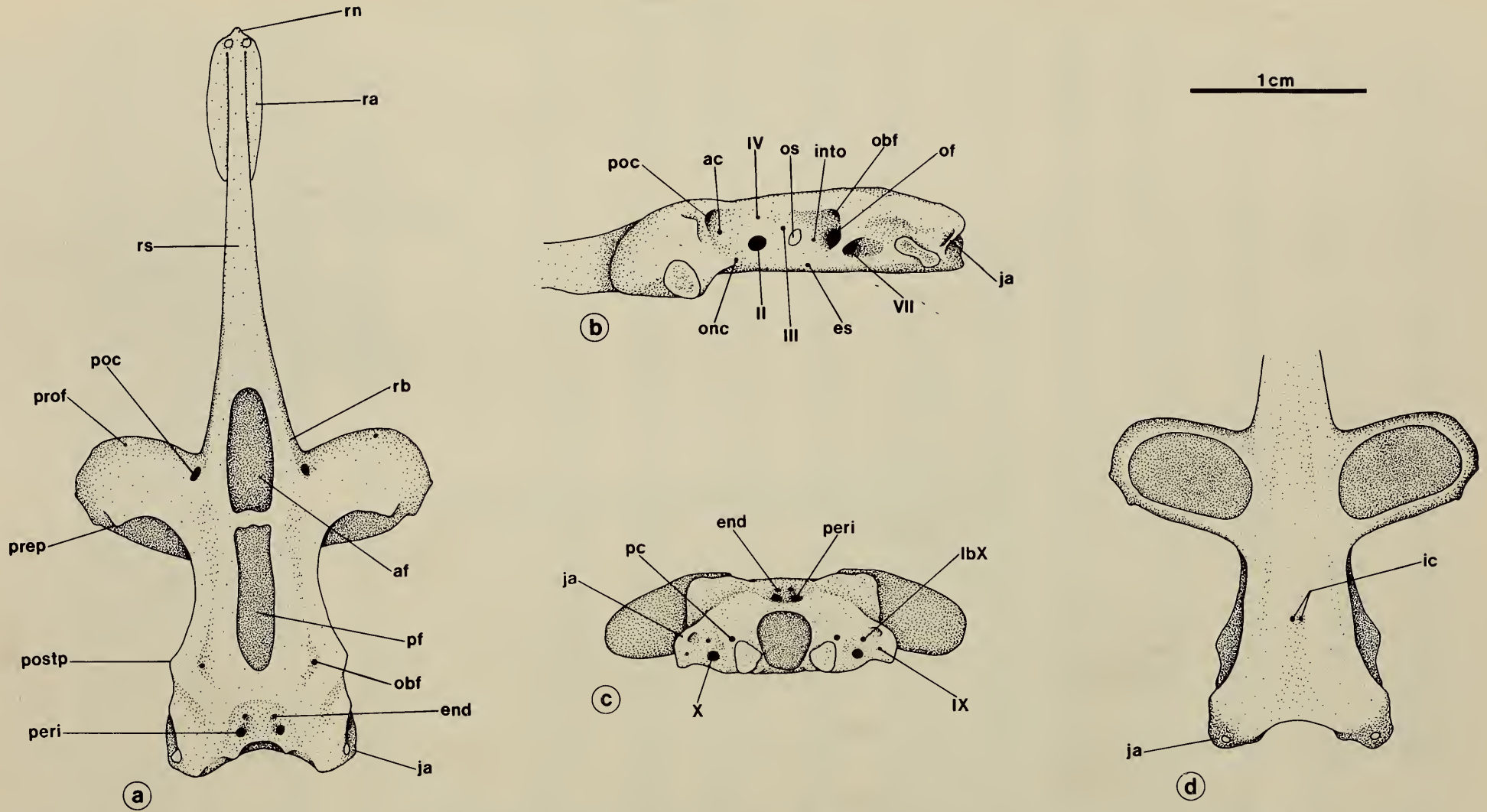

Fig. 3. Neurocranium of *R. heemstrai* USNM 231866 (Paratype). a. Dorsal view; b. Lateral view; c. Posterior view; d. Ventral view. ac—anterior cerebral vein foramen, af—anterior fontanelle, end—endolymphatic foramen, es—efferent spiracular artery foramen, ic—internal carotid artery foramen, into—intercerebral vein foramen, ja—jugal arch, IbX—lateralis branch of vagus nerve foramen, obf—otic branch of facial nerve foramen, of—orbital fissure, onc—orbitonasal canal foramen, os—optic stalk, peri—perilymphatic foramen, pf—posterior fontanelle, poc—preorbital canal foramen, postp—postorbital process, prep—preorbital process, prof—profundus nerve foramen, ra—rostral appendix, rb—rostral base, rn—rostral node, rs—rostral shaft, II—optic nerve foramen, III—oculomotor nerve foramen, IV—trochlear nerve foramen, VII—hyomandibular branch of facial nerve foramen, IX—glossopharyngeal nerve foramen, X—vagus nerve foramen.

Table 2. Neurocranial and scapulocoracoid measurements of *R. heemstrai* and *R. powelli* expressed as percentage of nasobasal length or scapulocoracoid length.

	R. heemstrai USNM 231866 419 mm TL	*R. powelli* BMNH 1939.5.24:17 347 mm TL
Nasobasal length (mm)	37.8	33.3
Cranial length	245	243
Rostral cartilage length	146	140
Prefontanelle length	123	120
Cranial width	111	122
Interorbital width	35	45
Rostral base	28	25
Anterior fontanelle length	39	44
Anterior fontanelle width	15	19
Posterior fontanelle length	40	38
Posterior fontanelle width	10	17
Rostral appendix length	58	27
Rostral appendix width	20	25
Cranial height	23	23
Width across otic capsules	52	51
Least width of basal plate	31	35
Greatest width of nasal capsule	41	47
Internasal width	26	26
Scapulocoracoid length (mm)	26.3	22.9
Scapulocoracoid height	61	56
Premesocondyle	46	38
Postmesocondyle	54	62
Postdorsal fenestra length	27	34
Postdorsal fenestra height	19	17
Anterior fenestra length	22	20
Anterior fenestra height	25	24
Rear corner	46	42

Preorbital length 4.2 (4.0–4.6) times as long as orbit; preoral length 2.5 (2.3–2.7) times internarial distance. Interorbital distance 0.9 (0.9–1.0) times length of orbit, orbit length 2.1 (2.0–3.0) times as long as spiracles. Anterior nasal flap (nasal curtain) fringed along distal margin, posterior nasal flap poorly developed and very weakly fringed. Upper and lower jaws slightly arched near symphysis. Teeth with pointed cusps near symphysis but with rounded cusps near margin of jaws (juvenile specimens with rounded cusps), teeth in quincunx arrangement.

Distance between first gill slits 1.8 (1.7–1.9) times as great as between nares; distance between fifth gill slits 1.0 (1.0–1.2) times as great as between nares; length of first gill slits 1.7 (1.4–2.2) times length of fifth gill slits and 0.2 times mouth width. First dorsal fin about equal in size and shape to second, second dorsal fin separated from epichordal caudal-fin lobe by distance equal to about one-half base of second dorsal fin; epichordal lobe of caudal fin relatively well developed, low, but base length equal to that of second dorsal fin.

Upper surface of disc, pelvics and tail devoid of dermal denticles. Ventral surface naked. Orbit with 3 (1–4) thorns on anteromedial margin and 2 (2–4) thorns on posteromedial margin; 1 thorn medial to each spiracle; 1 (2) nuchal thorn; tail with 3 (3–5) irregular rows of thorns on dorsal surface; 2 interdorsal thorns.

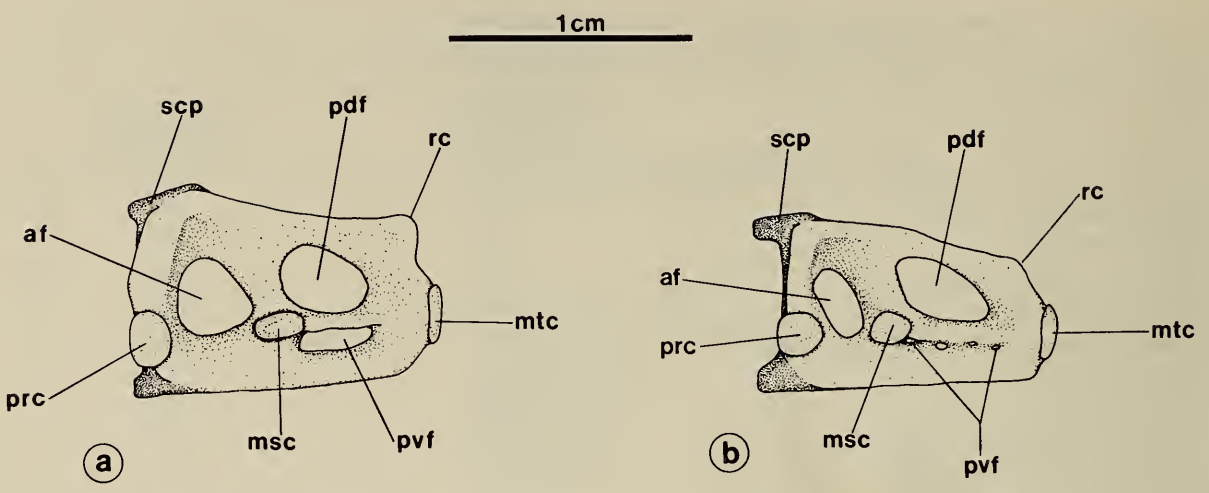

Fig. 4. Lateral view of scapulocoracoid. a. *R. heemstrai* USNM 231866 (Paratype), b. *R. powelli* BMNH 1939.5.24:17, 347 mm TL, male. af—anterior fontanelle, msc—mesocondyle, mtc—metacondyle, pdf—postdorsal fenestra, prc—procondyle, pvf—postventral fenestra or foramina, rc—rear corner, scp—scapular process.

Neurocranium with a relatively long and moderately slender rostral shaft (Fig. 3a, Table 2); rostral appendices flat, rather long and attached over the entire length to rostral shaft; propterygia of pectoral girdle extending to midlength of rostral shaft; nasal capsules small, rhomboid-shaped and set about 15° angle to transverse axis of neurocranium; foramen for profundus nerve on leading edge of nasal capsule; interorbital region moderately narrow (Table 2); preorbital processes poorly developed, continuous with incised supraorbital crests, postorbital processes poorly developed; anterior fontanelle elliptical; posterior fontanelle narrow with slightly convex lateral margins; foramen for anterior cerebral vein on a vertical with dorsal margin of optic nerve foramen and on a line connecting foramina for preorbital and orbitonasal canals (Fig. 3b); foramen for trochlear nerve dorsal to optic nerve foramen; jugal arches very slender (Fig. 3c); basal plate and nasal plate moderately broad (Fig. 3d).

Scapulocoracoids rather low and anteroposteriorly expanded both between procondyle and mesocondyle and between mesocondyle and metacondyle (Fig. 4a, Table 2); anterior, postdorsal and postventral fenestrae expanded; rear corner elevated.

Claspers of holotype and adolescent male paratype not fully formed but components appear to be present. Inner dorsal lobe possesses slit; inner ventral lobe possesses rhipidion, shield, funnel, sentinel and spike (Fig. 5).

Color.—After preservation in formalin and storage in alcohol, dorsal surface dark brown with numerous, fairly symmetrically arranged ocelli; ocelli bi-colored with a narrow yellowish-beige ring surrounding a brown or tan center, or ocelli lacking ring and appearing as a brown or tan spot. Ocelli ranging in size from ½ to 1 times diameter of orbit. Number of ocelli variable but arrangement similar on all specimens examined. Smaller specimens with a more distinct dorsal pattern, becoming muted in larger specimens. Margin of disc and sides of snout light tan. Dorsal and caudal fins dark brown. Ventral surface light gray with sooty-brown blotches scattered over disc, pelvic fins and tail. Tip of anterior lobes of pelvic fins white. Large female paratype has a dark gray ventral surface. In life, dorsal surface dark brown-black with pale yellow ocelli (Heemstra, pers. comm.).

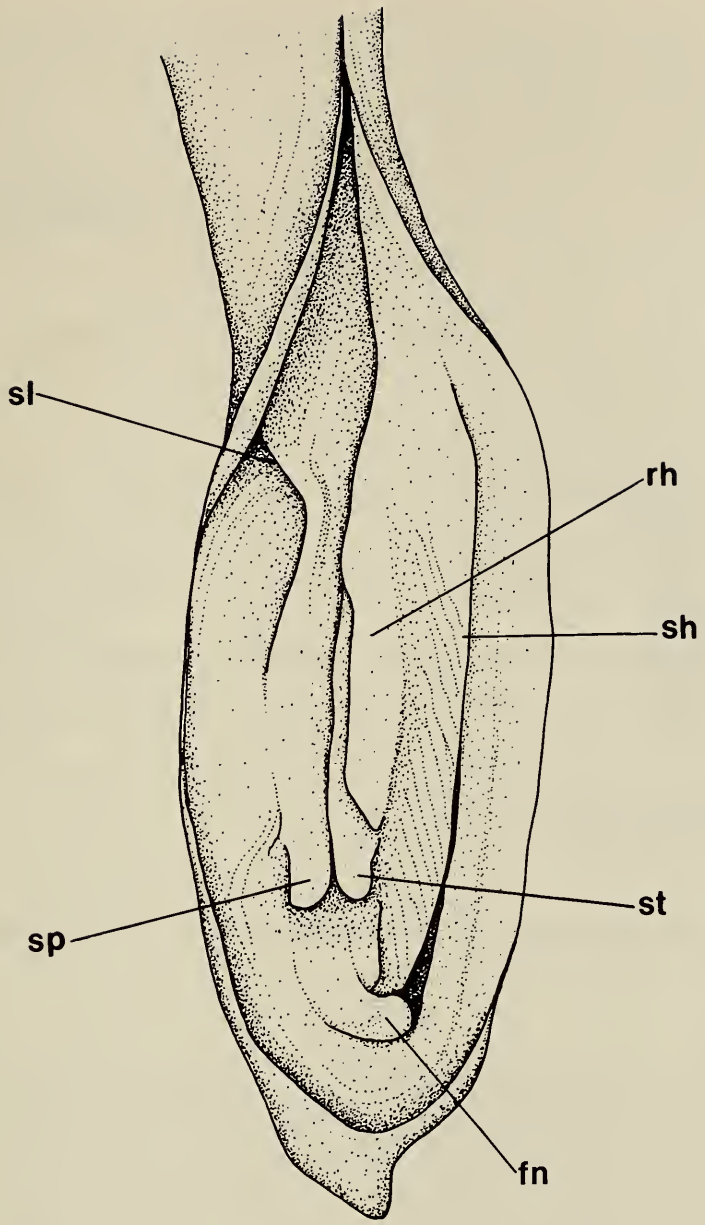

Fig. 5. Right clasper of *R. heemstrai* RUSI 13812 (Holotype), partially expanded to show components. fn—funnel, rh—rhipidion, sh—shield, sl—slit, sp—spike, st—sentinel.

Etymology.—Named after Phillip C. Heemstra (RUSI) who furnished us with five of the specimens of the new species and who has been extremely cooperative in furnishing us with elasmobranch material from South Africa.

Remarks.—*Raja heemstrai* most closely resembles *Raja* (*Okamejei*) *powelli* Alcock, 1898, which has been reported from the Gulf of Martaban (Burma) and the Gulf of Aden. Both species have rhomboid-shaped discs, rather long pointed snouts, and interspace between dorsal fins equal to or greater than the base of the first dorsal fin, and thus differ from the other *Okamejei* species which have less rhomboid, more rounded discs, shorter snouts, and an interdorsal space which is less than the base of the first dorsal fin (except *R.* (*O.*) *olseni* Bigelow and Schroeder, 1951, which has an interdorsal space equal to base of first dorsal fin).

Raja heemstrai and *R. powelli* can be distinguished from each other by several

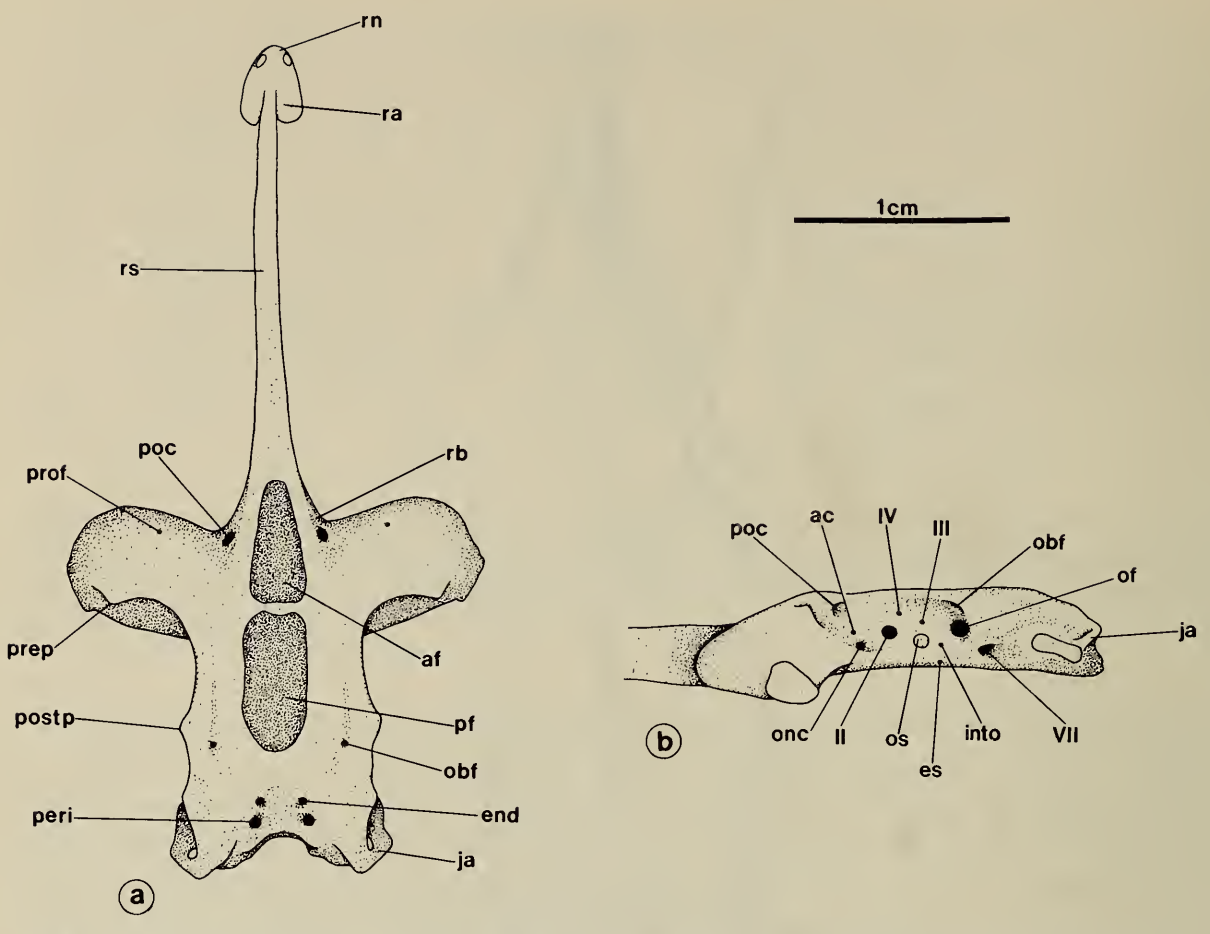

Fig. 6. Neurocranium of *R. powelli* BMNH 1939.5.24:17, 347 mm TL, male. a. Dorsal view, b. Lateral view. Abbreviations as in Fig. 3.

proportional measurements, number of tooth rows in the upper jaw, coloration, and structure of the neurocranium and scapulocoracoids. In *R. powelli* the orbit is less than the interorbital distance (greater in *R. heemstrai*), the preoral snout length is about two times the mouth width (2½ times in *R. heemstrai*) and the distance between the first gill slits and the fifth gill slits is greater in *R. powelli* than *R. heemstrai* (Table 1). *Raja powelli* possesses over 70 rows of teeth in the upper jaw (31–35 in *R. heemstrai*) and a single ocellus at the base of each pectoral fin (numerous ocelli in *R. heemstrai*). The neurocranium of *R. powelli* possesses more expanded nasal capsules, broader interorbital distance, shorter rostral appendices, and a more triangular anterior fontanelle than *R. heemstrai* (Fig. 6, Table 2). The scapulocoracoids of *R. powelli* are more anteroposteriorly expanded but less expanded between the procondyle and mesocondyle than in *R. heemstrai* and possess multiple postventral foramina rather than an expanded postventral fenestra (Fig. 4b, Table 2).

Stehmann (1976) tentatively placed *Raja philipi* Lloyd, 1906, in *Okamejei* although the holotype and only known specimen of this species from the Gulf of Aden is lost. However, the validity of *R. philipi* is suspect. Norman (1939) synonymized *R. philipi* and a species of *Raja* mentioned but not described as new by Annandale (1909) with *R. powelli*. Stehmann (1976) considered *R. powelli* and *R. philipi* distinct because of differences in the shape of the jaws, disc and nasal curtains. Several of the distinctions noted by Stehmann, which are based on the

original illustrations of the two species plus the two specimens of *R. powelli* from the Gulf of Aden (BMNH 1939.5.24:17–18), may be due to the state of preservation of the holotype of *R. philipi*. From Lloyd's illustrations (1908, Plates 40, 41) it appears that the jaws are partially protruded and that the pectoral fins are fixed in an unnatural position, i.e. the radials of the pectoral fins appear to be bent caudally along their lateral extremities and creases are evident in the flesh over the lateral aspect of the disc. Stehmann also justified recognition of both species on the basis of capture localities of the specimens. He stated that the type localities were the Gulf of Martaban, off Burma (*R. powelli*); Trevandrum, off the southwest tip of India (Annandale's specimen); and the Gulf of Aden (*R. philipi*). However, the two BMNH specimens of *R. powelli,* examined by Stehmann and by us, were captured in the Gulf of Aden, the type locality of *R. philipi*. It thus appears that *R. powelli* occurs along the entire northern Indian Ocean, suggesting that *R. powelli, R. philipi* and *R.* sp. of Annandale are synonymous. However, the status of *R. philipi* will remain uncertain until additional specimens are available for study.

Raja (*Okamejei*) most closely resembles *R.* (*Dipturus*). According to Ishiyama (1958, 1967) and Stehmann (1976) the two subgenera are distinguished by the following characters: 1. in *Okamejei,* snout about one-half head length (greater than one-half head length in *Dipturus*); 2. disc width 1.2–1.5 times tail length (1.5–1.8 times tail length); 3. more than one nuchal thorn (generally one or no nuchal thorns); 4. generally males with at least three rows of thorns on tail (males with a single row of thorns); 5. small to medium sized species (large to very large species); 6. proximal section of accessory terminal 1 cartilage of clasper distinctly biramous (proximal section of accessory terminal 1 cartilage not distinctly biramous); 7. anterior fontanelle of neurocranium with a distinct anterior margin (anterior fontanelle without a distinct anterior margin). In our opinion only one of these distinctions, the condition of the anterior fontanelle, is definitive. Snout length and tail length ratios of *Okamejei* and *Dipturus* form a more or less continuous series (Bigelow and Schroeder 1953, 1958, 1962; Wallace 1967; Hulley 1970). *Raja* (*Okamejei*) *olseni* Bigelow and Schroeder, 1951 lacks a nuchal thorn and *R.* (*D.*) *laevis* Mitchill, 1817 possesses three thorn rows on the tail. *Okamejei* species are small to medium sized and *Dipturus* species are large to very large, but the significance of this dichotomy is unknown. The proximal section of the accessory terminal 1 cartilage in *R.* (*D.*) *lanceorostrata* is distinctly biramous. The structure of the anterior fontanelle appears to be consistently distinct between the two subgenera but worldwide comparisons of species of both subgenera are needed to determine the validity and interrelationships of these two taxa.

Cruriaja andamanica (Lloyd, 1909)

The second known specimen of *Cruriraja andamancia* (ZMA 113.400) was captured off Tanzania with one of the paratypes of *R. heemstrai,* ZMA 113.399. This specimen closely resembles Lloyd's (1909) illustration of the holotype (Pl. 46, Fig. 2) and agrees with the proportional measurements listed by Stehmann (1976) despite the fact that the holotype, at the time it was measured, was in poor condition and in three pieces. The holotype differs from our specimen in possessing a shorter spiracle and greater distances between the first gill slits and

between the fifth gill slits (Table 1). Our specimen, like several other species of *Cruriraja,* possesses oronasal pits similar to these described in *Pseudoraja fischeri* (Bigelow and Schroeder, 1954), *Breviraja,* and *Neoraja* (McEachran and Compagno, 1982). *Cruriraja andamanica* thus occurs in both the western and eastern tropical Indian Ocean. Coloration of the two specimens is similar except that the ventral surface of our specimen is grayish pink rather than slate gray.

Acknowledgments

We wish to thank Philip C. Heemstra (RUSI), Han Nijssen and Vertus van Tuyl (ZMA), and Alwyne C. Wheeler and Peter J. P. Whitehead (BMNH) for furnishing the specimens for this study. Thanks are also extended to Steven Branstetter, Richard E. Matheson, Michael J. McCoid and Edward O. Murdy for suggestions which improved the manuscript. This study was supported in part by the National Science Foundation, Grant No. DEB 78-11217.

Literature Cited

Annandale, N. 1909. Report on the fishes taken by the Bengal fisheries steamer "Goldern Crown." Part I. Batoidei.—Memoirs of the Indian Museum, 2:1–60.

Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the western North Atlantic: sawfishes, guitarfishes, skates and rays, and chimaeroids.—Memoir One, Sears Foundation of Marine Research, 1(2):588 pp.

———, and ———. 1958. Four new rajoids from the Gulf of Mexico.—Bulletin of the Museum of Comparative Zoology, 119:201–233.

———, and ———. 1962. New and little known batoid fishes from the western Atlantic.—Bulletin of the Museum of Comparative Zoology, 128:162–244.

Hulley, P. A. 1970. An investigation of the Rajidae of the west and south coasts of southern Africa.—Annals of the South African Museum, 55:151–220.

Ishiyama, R. 1958. Studies on the rajid fishes (Rajidae) found in the waters around Japan.—Journal of the Shimonoseki College of Fisheries, 7:1–394.

———. 1967. Fauna Japonica. Rajidae (Pisces).—Tokyo Electrical Engineering College Press, Tokyo. 84 pp.

Lloyd, R. E. 1908. Illustrations of the zoology of the Investigator. Fishes. pt. 9–10, pls. 39–50. Calcutta.

———. 1909. A description of the deep-sea fish caught by the R.I.M.S. ship "Investigator" since the year 1900, with supposed evidence of mutation in *Malthopsis*.—Memoirs of the Indian Museum, 2:139–180.

McEachran, J. D., and L. J. V. Compagno. 1979. A further description of *Gurgesiella furvescens* with comments on the interrelationships of Gurgesiellidae and Pseudorajidae (Pisces, Rajoidei).—Bulletin of Marine Science, 29:530–553.

———, and ———. 1982. Interrelationships of and within *Breviraja* based on anatomical structures (Pisces, Rajoidei).—Bulletin of Marine Science, 32:399–425.

———, and J. D. Fechhelm. 1982. A new species of skate from Western Australia with comments on the status of *Pavoraja* Whitley, 1939 (Chondrichthyes, Rajiformes).—Proceedings of the Biological Society of Washington, 95:1–12.

Norman, J. R. 1939. Fishes.—Scientific Report of the John Murray Expeditions, 1933–1934, 7(1): 1–116.

Stehmann, M. 1976. Revision des Rajoiden—Arten des nordlichen Indischen Ozean und Indopazifik (Elasmobranchii, Batoidea, Rajiformes).—Beaufortia, 24(315):133–175.

Wallace, J. H. 1967. The batoid fishes of the east coast of southern Africa. Part III: Skates and electric rays.—Oceanographic Research Institute, Investigation Reports, Durban, 17:1–62.

(JDM) Department of Wildlife and Fisheries Sciences, and Department of Oceanography, (JDF) Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843.